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Studies on evaluation of deproteinized microcrystalline hydroxyapatite complex granules along with titanium miniplate for repair of mandibular fracture with bone defect in dogs

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Abstract

Mandibular fractures in dogs are commonly result from the trauma viz., dog bites and vehicle accidents, often these fractures leading to bone defects that complicate repair process. This study was conducted to evaluate the clinical efficacy of deproteinized microcrystalline hydroxyapatite complex (MCHC) granules combined with titanium miniplate fixation for mandibular fracture management in six dogs. Diagnosis involved physical and intraoral examination along with radiography to assess fracture configuration and healing progression. Following standard pre-operative preparation and general anaesthesia, fractures were reduced and stabilized using 2 mm titanium miniplates, and bone defects were filled with rehydrated MCHC granules. Postoperative care includes antibiotics, analgesics, fluid therapy, and dietary modification. Pain scores decreased steadily from pre-operative to 60 days of post-surgery. Clinically, all dogs showed progressive improvement in mandibular alignment, occlusion, and masticatory function. Radiographic evaluation revealed early callus formation by day 15 and complete bridging callus by day 60. No adverse reactions due to MCHC granules were observed. The combined use of titanium plating and MCHC granules provided stable fixation, enhanced bone regeneration, and supported early functional recovery. This approach proved effective for managing mandibular fractures with bone defects in dogs.

Keywords: Mandible, fracture, scaffold, titanium miniplate and granules

Introduction

A fracture refers to a disruption in the structural integrity of the bone, which might be either complete or incomplete. The incidence of mandibular fracture in dogs was highest due to dog fight (56.25%), followed by automobile accidents (25%), fall from height (12.50%), and the lowest incidence was occurred due to direct hit (6.25%) (Yelmule *et al.*, 2025) ^[12]. Diagnosis typically involves a combination of physical examination, intraoral examination, and imaging modalities such as radiography or computed tomography to assess fracture configuration and involvement of adjacent tissues (Scherer *et al.*, 2019) ^[10]. Using bone plates was a reliable way to hold the fracture bones firmly in place, it also helped in faster healing and early return to the normal activity of the animal. Compared to the other methods plating had less complications (Kern *et al.*, 1995) ^[3]. Autografts remain the accepted “gold standard” for bone repair, as they avoid immune reactions and provide growth factors, osteogenic cells and acts as structural scaffold for new bone formation (Rogers and Greene, 2012) ^[8]. However, their use is limited by long anaesthetic times, restricted availability, donor site complications, risk of infection, and possible failure (Pinto *et al.*, 2016) ^[5]. To overcome these drawbacks, recent studies have focused on bone regeneration using scaffolds. HA (Hydroxyapatite) had osteoconduction properties which provides a scaffold to enhance angiogenesis and osteogenesis at fracture site. The study was undertaken to document the clinical efficacy of deproteinized microcrystalline hydroxyapatite complex (MCHC) granules along with titanium plating technique for the repair of mandibular fracture with bone defect in dogs.

Materials and Methods

The present study was carried out among the six clinical cases of dogs presented to the Department of Veterinary Surgery and Radiology, Veterinary College Hospital, Hebbal, Bengaluru. Mandibular fracture with bone defect cases were selected for the study with irrespective of age, breed and sex. Anamnesis and orthopedic examination conducted in all selected cases (Table 1 and 2). Pain at the affected site was assessed, and scoring was done according to the University of Melbourne Pain Score (UMPS) scale described by Firth and Haldane (1999) [1]. Pain scoring, clinical and radiographic examination was recorded on before surgery, immediately after the surgery and on 7th, 15th, 30th, 45th and 60th day post-operatively. Confirmed cases with mandibular fracture were stabilized with titanium mini plating technique and defect was filled with MCHC granules.

Surgical implants: Straight, non-bridging titanium

miniplates (2 mm) and titanium mini-screws (2 mm diameter) were used. Screw length was selected based on the thickness of the mandible (Fig. 1).

Material used for Bone Regeneration

The deproteinized microcrystalline hydroxyapatite complex granules (FREOSI® Granules, 0.5gm, Fredun Pharmaceuticals Ltd., Palghar-01) of particle size 0.25mm to 1mm were used to fill the defect at the fracture site (Fig. 2). The granules were aseptically rehydrated with patients own blood before filling into the defect.

Radiographic examination

Animals selected for the study were subjected to radiography of dorso-ventral and open mouth lateral oblique skull with affected site towards cassette. The radiographs were evaluated for the type of fracture and progress of bone healing, where defect was filled with MCHC granules.

Table 1: Anamnesis of the animals considered for the study

Case no.	Breed	Age	Sex	Body weight (in kgs)	Cause of mandibular fracture	Duration of illness	Treated before (Y/N)
1.	Shih Tzu	1y 3m	M	6.4	FFH	2 days	N
2.	Shih Tzu	1y 8m	M	6.8	Automobile Accident	1 day	N
3.	Shih Tzu	1y 6m	F	6.2	FFH	4 days	N
4.	Shih Tzu	2 yrs	M	7.2	FOA	2 days	N
5.	Shih Tzu	3 yrs	M	7	FOA	2 days	N
6.	Shih Tzu	1 y 2m	M	5.8	FOA	2 days	N

*FFH-Fallen from height, FOA-Fight with other animals

Table 2: Details of orthopaedic examination of selected dogs with mandibular fractures

Case no	Breed	Side affected	Pain on palpation	Exposure of fractured bone to oral cavity	Blood mixed saliva	Crepitus (region)	Tooth region involved
1.	Shih Tzu	Right	+	-	+	+	408-409
2.	Shih Tzu	Left	+	-	+	+	308-309
3.	Shih Tzu	Right	+	-	+	+	408-409
4.	Shih Tzu	Left	+	+	-	+	309-310
5.	Shih Tzu	Left	+	+	+	+	308-309
6.	Shih Tzu	Right	+	-	+	+	408-409



Fig 1: Titanium miniplate and screws



Fig 2: Deproteinized MCHC granules

Pre-operative preparation

All animal owners were advised to withhold food for 12 hours and water for six hours for a pet, prior to the surgery. The surgical site was prepared aseptically. The oral cavity was washed with diluted povidone iodine mouthwash to remove the blood clots and reduce the oral microbial load. All animals under study were pre-medicated with Inj. Atropine Sulphate and after 10 minutes Inj. Xylazine Hydrochloride was administered as a sedative. Pre-operatively administered antibiotic inj. Ceftriaxone and pre-emptive analgesic Inj. Tramadol HCl intravenously 10 minutes before the induction of anaesthesia. The general anaesthesia was induced with 2.5% solution of Thiopental sodium at 12.5 mg per kg body weight intravenously and maintained with the same "to effect".

Surgical Procedure

After draping the surgical site, followed standard surgical approach to exposure the bone fragments, and with manual reduction fractured fragments were brought into normal anatomical alignment, and a 2mm titanium miniplate was positioned on the lateral surface of mandibular body. Avoiding the tooth root, holes were pre-drilled using 1.5mm drill bit. The plate was fixed using 2 mm screws of varying lengths according to mandibular thickness. Bone was purchased with total six screws *i.e.*, three screws on either side of the fractured line and leaving the one hole at the fractured site. After rigid fixation, the area was flushed with sterile saline to clear

debris. Deproteinized MCHC granules were rehydrated with 0.5 mL of blood collected from same animal. The defect was filled with rehydrated MCHC granules. Muscles were sutured with 2-0 Polydioxanone in simple interrupted

pattern. The platysma and subcutaneous fascia was apposed with same 2-0 Polydioxanone in simple continuous pattern. Finally, the skin incision was closed with 2-0 Polyamide in cross mattress pattern (Fig. 3).

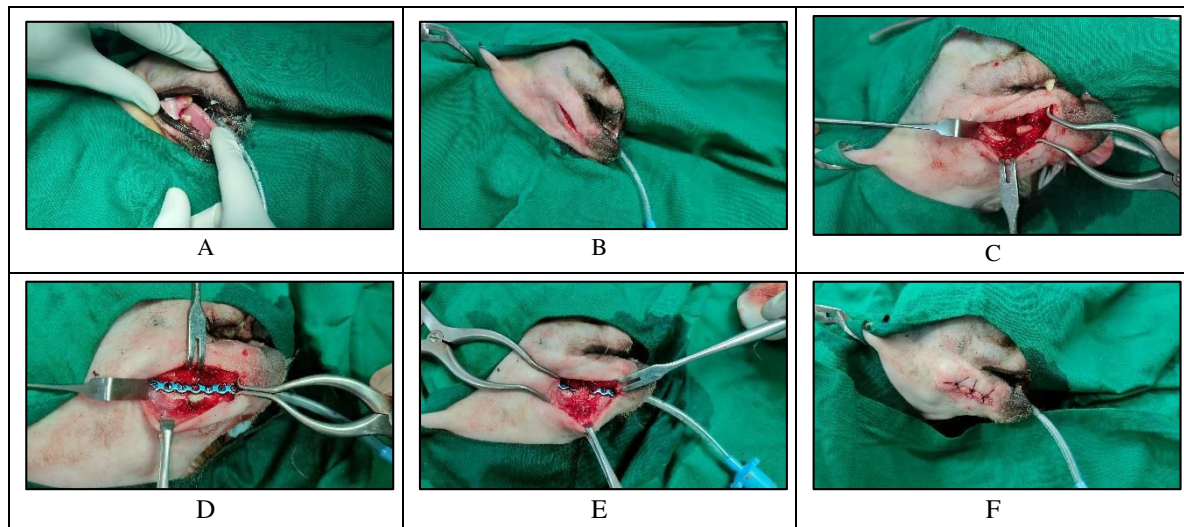


Fig 3: Surgical Procedure. A-Fracture cranial to M1 teeth, B-Skin incision, C- Exposure of fracture fragments, D-Stabilized fracture fragments with titanium miniplate, E-Defect filled with rehydrated MCHC granules, and F-Skin closure

Postoperative care and management

Post-operatively, the surgical wound was cleaned daily with Povidone-iodine solution and ointment Povidone-iodine was applied. Inj. Ceftriaxone was administered intravenously at 25 mg/kg twice daily for seven days to prevent any infection, while Inj. Tramadol was given intravenously at 2 mg/kg once daily for three days to manage pain. The animals were kept off feed for five days and maintained on DNS and RL infusions at 10 mL/kg twice daily, along with a daily intravenous injection of B-complex. Thereafter all animals had been maintained on a semi solid diet for upto 30th post-operative day. An Elizabethan collar was applied in all cases until suture removal, which was carried out on the 10th post-operative day after complete wound healing.

Results and Discussion

Pain assessment was conducted during the study period for all dogs using the University of Melbourne Pain Score (UMPS) scale. The average pain score before surgery was 14.33 ± 0.76 , which decreased post-operatively from 11.33 ± 0.42 to 1.20 ± 0.20 . Pain scores decreased markedly from

7th to 60th post-operative days. Higher values before and immediately after surgery were due to trauma, fracture instability, tissue damage from bone fragments, and surgical handling. Post-operatively, analgesics provided early relief, while callus formation and rigid plate fixation gradually eliminated pain over the study period. Similar findings were reported by Mahesh (2009) [4].

Clinical observations

Immediately after surgery, the mandible showed normal alignment with proper tooth occlusion. By the 7th post-operative day, animal started eating a semi-solid diet. By day 15, jaw movement and mouth closure were normal, with anatomical symmetry maintained. After 30 days, the animal was able to eat a regular diet without difficulty, and soft callus was palpable at the fracture site. By day 60, all dogs exhibited complete fracture stabilization, normal mandibular symmetry, and proper alignment of the jaws (Fig. 4). Similar findings were reported by Goswami (2015) [2], Snyder *et al.* (2016) [11], and Rashmitha (2022) [7].

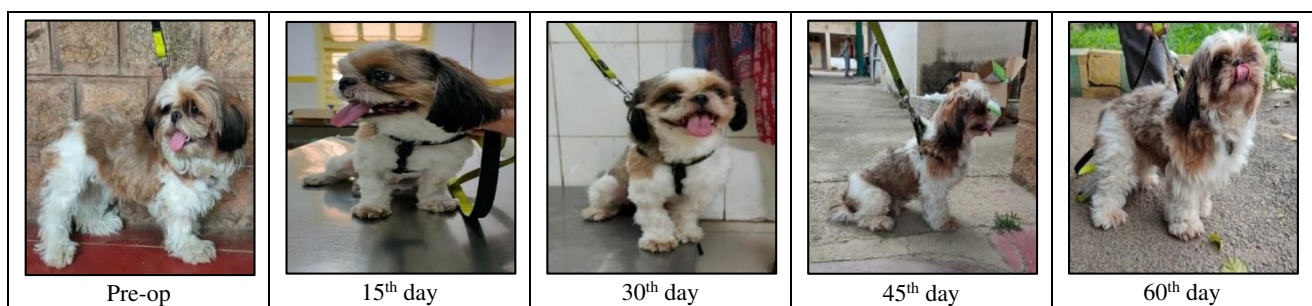


Fig 4: Clinical presentation of animal on different days

Radiographic observations

Immediately after surgery, radiographs showed proper placement of the titanium miniplate and screws with good alignment of fracture fragments, though MCHC granules were indistinct. By the 7th post-operative day, the plate

remained intact without screw loosening, and a clear fracture gap was visible, reflecting the early repair phase with granulation and fibrous tissue not detectable radiographically. On day 15, the plate and screws were stable, fracture alignment unchanged, and the fracture line

slightly narrowed, suggesting early callus formation. By day 30, alignment remained intact, plate was secure, and bridging callus was clearly visible, indicating progressive healing. On day 45, radiographs showed dense bridging callus with the fracture line barely visible, confirming continued bone repair. By day 60, complete bridging callus and indistinct fracture line were observed, with stable fixation and full healing progression. Implant removal kept optional in one case implant was removed on 150th post-operative day (Fig. 5). These findings align with previous reports by Goswami (2015) [2], Santos *et al.* (2015) [9], Preethi (2020) [6] and Rashmitha (2022) [7].

In all six cases mandibular fractures were stabilized using 2mm Titanium miniplate and screws. The implant provided

adequate rigidity, strength, stability to the fracture site throughout the study period and enabled eating within a short period. Titanium had a combination of strength, fatigue resistance, and biocompatibility ensured long-term durability and reduced the risk of mechanical failure, even under continuous movement of mandible. No adverse tissue reactions were observed in any of the cases following the use of MCHC granules, thus confirming its full biocompatibility and it also helped in faster healing. The presence of collagen in the granules might have stimulated osteoblast differentiation, enhanced bone formation, reduced healing time, and improved the mechanical performance of brittle hydroxyapatite.

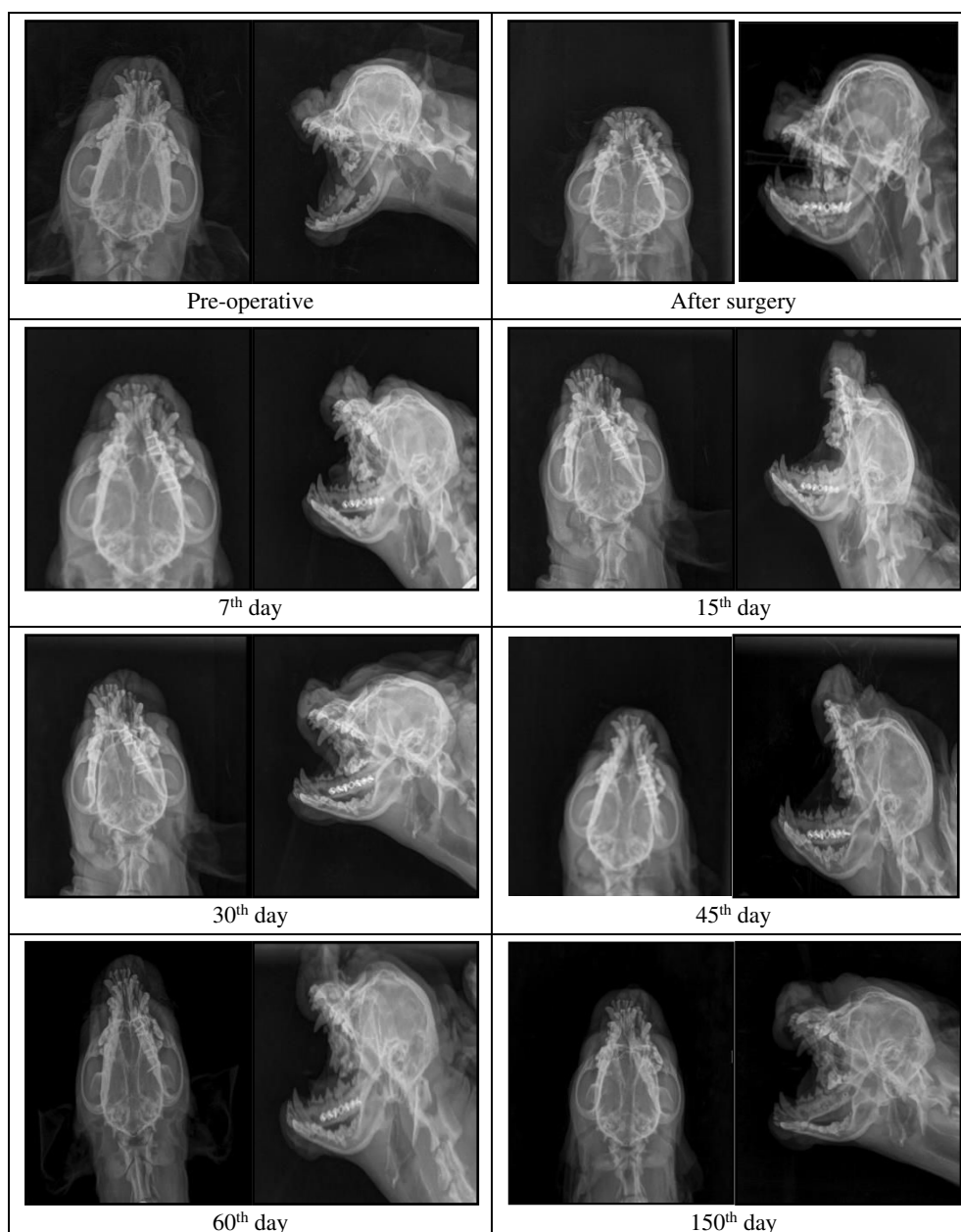


Fig 5: Dorsoventral and open mouth lateral oblique skull radiographs on pre-operative and post-operative days

Conclusion

The application of deproteinized microcrystalline hydroxyapatite complex granules for defect filling in mandibular fracture fixation proved effective, promoting early callus formation through their osteoconductive

properties and thereby shortening the healing period. Titanium implants were found to be highly suitable for mandibular fractures, as the plating technique was simple, not time consuming, and easily adaptable to the contour of the mandible.

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